

Experimental Observations

ON THE

ANTISEPTIC ACTION OF HYPOCHLOROUS ACID AND ITS APPLICATION TO WOUND TREATMENT.

BY

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The primary object of the following investigation was to find an antiseptic which could be applied as a first dressing in the field to prevent sepsis.

The ideal antiseptic for the type of infection which occurs in wounds received in the field must possess the power of rapidly destroying spores as well as ordinary bacterial forms. There are two chief laboratory methods of investigating the action of antiseptics:

1. By testing their action in killing or preventing the growth of organisms on artificial culture media.
2. By testing their action in sterilizing infected organic matter.

In our investigation we employed both methods, but especially the latter, as the conditions here resemble more closely those occurring in infected wounds containing much necrotic tissue or other organic matter.

The result of preliminary observations was to direct attention to the hypochlorites. It has been accepted, especially by those working at disinfectants for public health purposes, that the hypochlorites are among the most potent germicides. Rideal, using carbolic acid as a standard, expresses the germicidal power of hypochlorites as follows: Carbolic acid, 100; hypochlorites, 14,600 to 22,000.

The hypochlorites, used mainly in the form of bleaching powder, have been largely employed for sterilizing water supplies, but their use in general surgery as antiseptics has been very limited. It is an interesting fact that as far back as 1846 Semmelweis stamped out an epidemic of puerperal fever in Vienna by the use of bleaching powder.

Solutions of alkali hypochlorites, for example "Eau de Javelle," have been used with success in surgical practice. The fundamental practical difficulty in the use of hypochlorites is that in solution they rapidly lose their strength by decomposition. In the case of Eau de Javelle this difficulty has been overcome by making a strongly alkaline solution; but this constitutes a new difficulty, in that such a highly alkaline solution cannot be applied to the tissues unless greatly diluted.

In our observations on the hypochlorites we found that hypochlorous acid is a more potent germicide than its salts, and we have accordingly devised a method in which the free acid is employed as the antiseptic agent. The acid may be used as a gas or as a solution in water.

HYPOCHLOROUS ACID.

For use as an antiseptic the gas is most conveniently prepared by the action of boric acid on bleaching powder in the presence of a small quantity of water. The solution is obtained when the same action occurs in the presence of a large quantity of water.

For convenience we have given the name "Eupad" to a powder consisting of equal weights of finely ground bleaching powder and powdered boric acid intimately mixed; while the solution of free hypochlorous acid prepared in this way we have named "Eusol."

METHODS OF PREPARATION AND CHEMICAL NOTES.

To prepare Eupad, ordinary commercial bleaching powder or chloride of lime is ground in a mortar to a fine powder, and then intimately mixed with an equal weight of boric acid powder. The mixture should be kept in closely stoppered bottles, and not exposed to light more than necessary.

Eusol may be prepared by two methods:

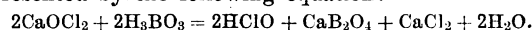
1. Twenty-five grams of Eupad are shaken up with 1 litre of water, allowed to stand for a few hours, then filtered through cloth or filter paper.
2. To 1 litre of water add 12.5 grams bleaching powder, shake vigorously, then add 12.5 grams boric acid powder and shake again. Allow to stand for some hours, preferably overnight, then filter off, and the clear solution is ready for use.

This solution contains:

Hypochlorous acid	...	...	0.54 per cent.
Calcium baborate	...	...	1.28 "
Calcium chloride	...	...	0.17 "
Total...	...	...	1.99

The hypochlorous acid is estimated by titration with N/10 arsenious acid solution; this method is best, as the presence of chlorates does not affect the result.

The chemical reaction involved in the preparation of hypochlorous acid by the method described may be represented by the following equation:



If the reaction takes place in the presence of a large quantity of water, a solution of hypochlorous acid is formed; if little water is used, gaseous hypochlorous acid is given off.

The hypochlorous acid in the form of a gas is more mobile, and will be absorbed by the tissue more rapidly and in larger quantity than from the solution; this will explain its greater efficiency as an antiseptic.

As the ultimate decomposition product in the tissue is hydrochloric acid or sodium chloride, there is no reason to fear toxic absorption from this antiseptic.

A concentration of 0.5 per cent. hypochlorous acid has been found the most satisfactory. Stronger solutions may be prepared by this method, but no advantage is gained, as they rapidly lose strength, coming down to about 0.5 per cent. free acid, after which they decompose more slowly; for practical purposes a solution of 0.5 per cent. remains effective for from three weeks to a month. The rate of decomposition may be seen from the following experiments:

Solutions made up—

(1) March 25th, 1915	...	...	0.83 per cent.
" 26th, "	...	...	0.76 "
April 15th, "	...	...	0.33 "
(2) March 25th, 1915	...	...	0.42 per cent.
" 26th, "	...	...	0.4 "
April 15th, "	...	...	0.3 "
(3) March 11th, 1915	...	...	2.02 per cent.
" 12th, "	...	...	1.5 "
" 16th, "	...	...	0.78 "

From these results it appears that a solution originally 0.83 per cent. decomposes to 0.3 per cent. in the same period as a 0.4 per cent. solution. A solution of even 0.25 per cent. HClO has been found effective as an antiseptic both by experiment and in surgical practice.

Andrewes and Orton² carried out an important elaborate investigation on the value of hypochlorous acid as a disinfectant. They found that very dilute solutions of hypochlorous acid have intense antiseptic properties. They showed that a suspension of *Staphylococcus pyogenes aureus* in pure distilled water was sterilized in one minute by the presence of 1 part of HClO in 100,000. In a suspension in broth 1 in 5,000 did not, but 1 in 3,000 did, kill the staphylococcus in 30 minutes. From this they concluded that the potency of the pure acid was so much diminished by the presence of organic matter that it was unsuited to ordinary use.

We carried out various tests on the decomposition of much stronger solutions in the presence of organic matter.

Decomposition in the Presence of Organic Matter.

1. To 100 c.cm. of 0.4 per cent. HClO there was added 1 gram of intestine; this was kept at room temperature and the solution tested at intervals:

Original solution	...	...	= 0.4 per cent.
After 30 minutes	...	...	= 0.34 "
After 105 minutes	...	...	= 0.30 "

2. A similar experiment:

Original solution	...	...	= 1.6 per cent.
After 30 minutes	...	...	= 1.5 "

3. To 5 c.cm. of broth were added 5 c.cm. 0.5 per cent. HClO:

Solution, giving	...	...	0.25 per cent.
After 30 minutes	...	...	0.18 "

4. Experiment similar to (3);

Original solution	...	...	= 0.8 per cent.
After 5 minutes	...	...	= 0.8 "
After 30 minutes	...	...	= 0.7 "

As a solution of 0.5 per cent. HClO may be safely applied to open wounds, the objection which Andrewes and Orton have based on experiments with very dilute solutions does not apply.

EXPERIMENTAL TESTS.

1. Preliminary.

In the first series of observations relatively small amounts—15 to 30 c.cm.—of the antiseptic to be tested were used. Equal portions of large intestine, or other infected tissue obtained in the *post-mortem* room, were exposed for definite times at room temperature to the action of the antiseptic. The tissue was then washed in several changes of sterile water and incubated in peptone broth. The results were read in twenty-four and forty-eight hours. It is unnecessary to detail these. The following antiseptics were tested:

Phenol	Salicylic acid (1 per cent. alcoholic solution)
Acrosyl	Sod. salicylate (10 per cent. aqueous)
Kymol	Methyl salicylate (10 per cent. in spirit)
Chinosol (1 in 3,000)	Glycerine
Hydrogen peroxide	Bleaching powder (10 per cent.)
Mercury bichloride (1 in 1,000 aqueous)	Bleaching powder and hydrogen peroxide
Tinct. iodi mit.	Boric acid (saturated aqueous solution)
Potassium permanganate (4 per cent.)	
Methylated spirit	
Turpentine	

In the above experiments the infected tissue was sterilized on one occasion only—namely, where 1 in 20 phenol had acted for thirty minutes. In all the others growth occurred within twenty-four hours.

These results were probably due in part to the fact that so small an amount of antiseptic was used. The amount of antiseptic used has been shown to have a very important influence on the result (Chick and Martin²).

In the second series of experiments larger amounts of antiseptic were used; as a rule 200 c.cm. The details of these are shown in the following table.

(D).—The tissue used in this series was child's intestine. Consequently there was less thickness of tissue to penetrate.

Amount.	Antiseptic and Strength.	Time.	Growth.	
			24 hrs.	48 hrs.
200 c.cm....	Phenol, 1 in 20	30 min.	—	?
200 c.cm....	Salicylic acid, 1% in alcohol	30 min.	?	+?
200 c.cm....	Sod. salicylate, 10%	30 min.	++	++
200 c.cm....	Bleaching powder, 10%	30 min.	—	—
200 c.cm....	Chinosol, 1 in 500	30 min.	++	+++
200 c.cm....	Eau de Javelle	30 min.	—	—
200 c.cm....	H ₂ O ₂ (10 vols.)	30 min.	++	+++
300 c.cm....	H ₂ O ₂ (3 vols.), 100 c.cm.; bleaching powder, 10%, 200 c.cm.	40 min.	—?	++
80 c.cm....	Iodine	30 min.	+	++
200 c.cm....	Boric acid, saturated at 37° C.	50 min.	—	+

From this table it is seen that only bleaching powder solution and 1 in 20 phenol were effective. The boric acid solution tested at 37° C. for fifty minutes could not be exactly compared.

E.—A similar series on large intestine gave no sterilization with any antiseptic.

F and G.—Tissue used was large intestine; 1.2 grams were taken, and parallel tests were made at room temperature and at 37° C.

In this series bleaching powder, 10 per cent. and 5 per cent., was the most effective in preventing or inhibiting growth; iodine and 1 in 20 phenol caused some inhibition.

2. Experiments with the Powder "Eupad."

K.—This was the first experiment in which free hypochlorous acid was employed as a gas. The amount of

intestine used was 1 gram. Each portion was subjected to the action of the antiseptic for thirty minutes. In the first observation a 10 per cent. solution of bleaching powder was used, but in the others 1 gram of dry powder was spread around the piece of intestine and moistened with a few drops of water. The pungent odour of hypochlorous acid given off when the proportion of bleaching powder to boric acid was 1 in 1 was much more noticeable than in the other proportions.

	24 hrs.	60 hrs.
10% bleaching powder	—	+
1 bleaching powder to 3 boric acid	—	++
1 bleaching powder to 2 boric acid	—	—
1 bleaching powder to 1 boric acid	—	—
Bleaching powder alone	—	+++
Boric acid powder alone	++	+++
Tissue alone	+++	++++

The conclusion from the above was that hypochlorous acid was more effective than hypochlorite.

C.C.—Effect of Gaseous Hypochlorous Acid.

In Nos. (1) and (2) the intestine was separated from the moistened powder by a layer of corrugated and damped filter paper. In No. (3), 1 gram of the moistened powder in a watch-glass was placed in a Petri dish alongside of, but not in contact with, a piece of intestine; thus only the gas was allowed to act, and that at a distance.

Antiseptic.	Tissue.	Time.	Result.
(1) The gas set free from 1 gram moistened Eupad	1 gram child's intestine	24 hrs. at 37° C.	Sterile
(2) The gas set free from 1 gram moistened Eupad	1 gram child's intestine	2 hrs. at 37° C.	Sterile
(3) The gas acting at a distance...	1 gram child's intestine	24 hrs. at 37° C.	Sterile

NOTE.—In each case the hypochlorous acid was neutralized, at the end of the specified time, by a solution of sodium thiosulphate. Control experiments on tissue untreated with antiseptic, but similarly washed, gave copious growths in culture.

E.E.—A Similar Experiment with Adult Intestine from a Case of Generalized Peritonitis.

Antiseptic.	Time.	Result. Growth in	
		24 hrs.	48 hrs. and later.
(1) 2 grams Eupad moistened and covered with filter paper (same as in C.C. (1))	24 hrs. at 37° C.	—	—
(2) 2 grams Eupad moistened and covered with filter paper (same as in C.C. (1))	1 hr. at 37° C.	? +	+
(3) 1 gram used as in C.C. (3)	24 hrs. at 37° C.	—	—
(4) 1 gram used as in C.C. (3)	1 hr. at 37° C.	+	+

F.F.

Antiseptic.	Tissue.	Time.	Result. Growth in	
			24 hrs.	48 hrs. and later.
(1) 2 grams moistened Eupad applied over all surfaces of tissue	1 gram adult intestine much swollen	24 hrs. at 37° C.	—	—
(2) 2 grams moistened Eupad applied over all surfaces of tissue	1 gram adult intestine much swollen	1 hr. at 37° C.	—	—
(3) 1 gram moistened Eupad applied over all surfaces of tissue	1 gram adult intestine much swollen	20 hrs. at room temp.	—	—

The conclusion from these series of experiments was that where the gaseous acid alone was acting a marked sterilizing result followed. Where the exposure was for only one hour sterilization was produced in one case out of the three.

In all these experiments the large intestine was used; the pieces selected were of the same weight, and relatively of the same thickness. In some cases the intestine was incubated overnight. In all cases there was a strong fetor. The bacteriology was not investigated in each case, but in several instances an examination revealed the presence of innumerable organisms, both spore bearers and ordinary forms.

Immediately on the application of the gas the odour disappeared. After the action had proceeded for some time a distinct bleaching effect was produced.

3. Experiments with the Solution Eusol.

In the following experiments the strength of the hypochlorous acid is given in each case; in several instances stronger solutions than the standard 0.5 per cent. were employed. These experiments were similar to those already described for the other antiseptics. Phenol 1 in 20 was used as a control in most instances.

L.

Antiseptic.	Tissue: Pneumonic Lung.	Time.	Result. Growth in	
			24 hrs.	48 hrs.
(1) 50 c.cm. unfiltered emulsion, approximately 2% HClO	1.0 gram 2.5 "	30 min. "	? - ? -	++ ++
(2) 50 c.cm. filtrate, approximately 2% HClO	1.0 gram 2.5 "	30 min. "	- -	+ ++
(3) 50 c.cm. bleaching powder, 10% solution	1.0 gram 2.5 "	30 min. "	+ ? -	++ ++
(4) 50 c.cm. phenol 1 in 20	1.0 gram 2.5 "	30 min. "	? + +	++ +++
Control: Tissue alone	...	...	++	+++
Comparison with Eusol— (1) Moistened powder	1.0 gram 2.5 "	30 min. "	- -	- -
(2) Moistened powder	1.0 gram 2.5 "	10 min. "	- -	- +

NOTE.—The different weights of lung used were of different thickness, the 2.5 gram being approximately twice as thick as the 1.0 gram. In all these experiments growth occurred after 48 hours, showing that penetration had not been sufficient. Experiments with dry powder on the same tissue have been added for comparison, and here it will be noticed that even after only ten minutes' exposure almost complete sterilization has been effected. This tissue contained living spore-bearing bacilli.

Further Observations on the Sterilizing Effect on Intestine of Hypochlorous Acid in Different Strengths, and comparison with Bleaching Powder and Phenol.

D.D.

Antiseptic.	Tissue.	Time. Room Temp.	Result. Growth in		
			24 hrs.	48 hrs.	72 hrs.
(1) 100 c.cm. HClO 1.0% (= 0.7% Cl)	1 gram child's colon	30 min.	-	-	-
(2) 100 c.cm. bleaching powder solution (= 0.78% Cl)	Do.	"	-	-	-
(3) 100 c.cm. phenol 1 in 20	Do.	"	-	+	++
Control: Intestine alone			+++		
(5) 100 c.cm. HClO 1.66% (= 1.12% Cl)	Adult's colon 1 gram	30 min.	-	-	*
(6) 100 c.cm. bleaching powder solution (= 1.12% Cl)	Do.	"	+	+	+
(7) 100 c.cm. eau de Javelle (= 1.12% Cl)	Do.	"	-	-	-
(8) 100 c.cm. phenol 1 in 20	Do.	"	-	-	-
Control, unwashed ...			++	+++	+++
Control, washed with thiosulphate			++	+++	+++

* Subculture + after 72 hours.

G.G.

Antiseptic.	Tissue.	Time. Room Temp.	Result. Growth in		
			24 hrs.	48 hrs.	72 hrs.
(1) 100 c.cm. HClO 3.2% ...	1 gram adult colon	30 min.	-	-	-
(2) 100 c.cm. HClO 1.6% ...	Do.	"	? +	+	+
(3) 100 c.cm. phenol 1 in 20	Do.	"	+	+	+
Control washed for one hour in thiosulphate...			++	+++	+++

H.H.

Antiseptic.	Tissue.	Time. Room Temp.	Result. Growth in		
			24 hrs.	48 hrs.	72 hrs.
(1) 100 c.cm. HClO 0.5% ...	1 gram very putrid adult colon	22 hrs.	-	-	+
(2) 100 c.cm. HClO 0.5% ...	Do.	"	-	-	+
(3) 100 c.cm. HClO 0.5% ...	Do.	"	-	-	+
(4) 100 c.cm. phenol 1 in 40	Do.	"	+	+	+
(5) 100 c.cm. phenol 1 in 40	Do.	"	+	+	+
(6) 100 c.cm. phenol 1 in 20	Do.	"	-	-	-
Control: Intestine alone			++++	++++	++++

K.K.

Antiseptic.	Tissue.	Time. Room Temperature.	Result. Growth in	
			24 hrs.	48 hrs.
(1) 100 c.cm. HClO 0.5%	1 gram child's colon	30 min.	+	+
(2) 100 c.cm. HClO 0.5%	Do.	"	-	+
(3) 100 c.cm. HClO 0.5%	Do.	60 min.	-	+
(4) 100 c.cm. HClO 0.5%	Do.	"	+	+
(5) 100 c.cm. HClO 0.5%	Do. (thin portion)	24 hours	-	-
(6) 100 c.cm. HClO 0.5%	Do. (thick portion)	"	-	+
(7) 100 c.cm. HClO 0.25%	Do. (thin portion)	"	-	-
(8) 100 c.cm. HClO 0.25%	Do. (thick portion)	"	-	+
(9) 100 c.cm. phenol 1 in 20	Do.	30 min.	+	+
(10) 100 c.cm. phenol 1 in 20	Do.	"	+	+
(11) 100 c.cm. phenol 1 in 20	Do.	60 min.	+	+
(12) 100 c.cm. phenol 1 in 20	Do.	"	+	+
(13) 100 c.cm. phenol 1 in 40	Do. (thin portion)	24 hours	+	+
(14) 100 c.cm. phenol 1 in 40	Do. (thick portion)	"	+	+
Control: Intestine alone			++	++

In all the above experiments the tissue after exposure to the hypochlorous acid was washed in sterile water and sterile thiosulphate until no trace of hypochlorous acid could be detected.

The thickness and state of decomposition of the portions of intestine determine the result to a large extent.

Hypochlorous acid 0.5 per cent. never completely sterilized the tissue when applied for thirty minutes; in that time, however, 3.2 per cent. HClO gave complete sterilization with adult colon. In twenty-four hours, at room temperature 0.5 per cent. hypochlorous acid did produce complete sterilization, though not invariably; and even 0.25 per cent. gave this result.

If the result of the application of the powder to intestine be referred to, it will be seen that much more uniform sterilization occurred; the antiseptic in this case being in the gaseous form.

In the control experiments with phenol, occasional sterilization occurred with 1 in 20, but failed with 1 in 40. Great variation in the action of 1 in 20 phenol was noticed in all the experiments; it is possible this may be due to

the presence or absence of spore-bearing organisms. As will be seen below, phenol has little action on spores.

4. Experiments with Cultures of Organisms on Artificial Media.

O. The organisms used were *B. coli*, *Staphylococcus pyogenes aureus*, *B. anthracis* (spores in culture). Hypochlorous acid 0.5 per cent. was applied, and control experiments were done with 1 in 20 phenol; 10 c.cm. of antiseptic were added to 10 c.cm. of a broth culture, or to an agar slope culture. Most of the experiments were carried out at 37° C. The results are shown in tabular form:

Antiseptic.	Medium.	Organism.	Time of Application and Result.		
			2 min.	15 min.	30 min.
HClO 0.5% ...	Broth	<i>B. coli</i>	—	—	—
HClO 0.5% ...	Broth	<i>Staphylococcus</i>	—	—	—
HClO 0.5% ...	Broth	<i>B. anthracis</i>	—	—	—
HClO 1.0% ...	Agar	<i>B. coli</i>	—	—	—
HClO 1.0% ...	Agar	<i>Staphylococcus</i>	—	—	—
HClO 1.0% ...	Agar	<i>B. anthracis</i>	—	—	—
Phenol 1 in 20 ...	Agar	<i>B. coli</i>	—	—	—
Phenol 1 in 20 ...	Agar	<i>Staphylococcus</i>	—	—	—
Phenol 1 in 20 ...	Agar	<i>B. anthracis</i>	+	+	+

P.

Antiseptic.	Medium.	Organism.	Time of Application (5 min.) and Result.
HClO 0.67% ...	Agar	<i>B. anthracis</i>	—
HClO 0.9% ...	Agar	<i>B. anthracis</i>	— washed as usual.
HClO 0.9% ...	Agar	<i>B. anthracis</i>	— unwashed.
Phenol 1 in 20	Agar	<i>B. anthracis</i>	+

R.

Antiseptic.	Medium.	Organism.	Time of Application and Result. (Room Temperature.)		
			1 min.	2 min.	3 min.
HClO 0.23%	Agar	<i>B. anthracis</i>	+	+	+ not washed.
HClO 0.36%	Agar	<i>B. anthracis</i>	+	+	+ not washed.

NOTE.—In the case of the broth cultures, after treatment with the antiseptic a small quantity was taken and added to a fresh culture tube. The agar cultures were first washed with sterile water and then subcultures made.

From the above tables it will be seen that 0.5 per cent. hypochlorous acid in every case killed the organisms even with only two minutes' exposure. Anthrax spores were killed as readily as the non-sporing organisms. While phenol 1 in 20 killed *staphylococcus* and *coli*, it failed to affect the anthrax, even after thirty minutes' exposure.

Weaker strengths of hypochlorous acid than 0.5 per cent. failed to kill anthrax spores in three minutes at room temperature.

V.—Experiments on Subtilis Spores with Eusol, Eau de Javelle, and Phenol.

An emulsion of *subtilis* spores was filtered through glass wool, and one drop of emulsion was added to 1 c.cm. of the antiseptic; after five minutes the antiseptic was neutralized by sodium thiosulphate solution, and the whole was then mixed with 10 to 15 c.cm. of broth and incubated. The experiments were carried out at room temperature.

A.

Antiseptic.	Result: 24 hrs.	Growth in 1 week.
(1) HClO 0.5% (= 0.35% Cl) ...	—	—
(2) Bleaching powder solution (= 0.35% Cl) ...	? —	+
(3) Eau de Javelle (= 0.32% Cl) ...	? —	+
(4) *Phenol 1 in 20 ...	—	—

* As the phenol could not be neutralized as in the case of the other antiseptics a relatively large amount remained in the culture, and thus the negative result is not a true value.

B.—The same series of experiments was done, but the thiosulphate was added to the antiseptic before the emulsion was put in, the antiseptic being thereby neutralized before the bacteria were added. The phenol, as before, remained in the culture unaltered. The order, therefore, of the two series was as follows:

A. = Antiseptic, emulsion, thiosulphate, broth.

B. = Antiseptic, thiosulphate, broth, emulsion.

The result of B. was as follows:

(1) + (2) + (3) + (4) (phenol) —.

W.—Experiments with Anthrax, Sporing Culture.

The method was similar to that used in V. (A.).

One drop of filtered anthrax emulsion was added to 1 c.cm. of the antiseptic solution, and at intervals of one, two, and five minutes one loopful of this was taken out and inoculated into a tube of broth and incubated.

Antiseptic.	Time of Exposure.	Growth after	
		24 hrs.	48 hrs.
(1) Eusol (0.5 % HClO) (=0.35% Cl): ...	1 min.	—	—
	2 ..	—	—
	5 ..	—	—
(2) Eau de Javelle (=0.32% Cl) ...	1 min.	+	+
	2 ..	+	+
	5 ..	—	—
(3) Phenol (1 in 20) ...	1 min.	+	+
	2 ..	+	+
	5 ..	+	+

A further experiment was done on the same lines, but using five loopfuls instead of one to inoculate the broth tube. This gave the same result.

A.A.—This is a similar experiment with weaker solutions of hypochlorous acid on anthrax spores.

Antiseptic.	Time of Application.	Result.
HClO 0.25% ...	1 min.	4 tubes inoculated; only one remained sterile.
HClO 0.25% ...	1 min.	4 tubes inoculated, and all gave a growth of anthrax.

It will be noticed from the above that while 0.5 per cent. hypochlorous acid was effective in killing anthrax spores in one minute, 0.25 per cent. was too weak; and only succeeded in 1 out of 8 experiments.

L.L.—Experiments on the Effect of the Gaseous Hypochlorous Acid on Anthrax Spores.

A sporing culture was spread upon pieces of filter paper, which were then dried. The gas was prepared by the action of a few drops of water on 1 gram of Eupad; this was placed in a watch-glass in a Petri dish. The piece of filter paper to be tested was placed in the Petri dish alongside, but not in contact with, the watch-glass. Two series were done—one in which the paper was moistened; the other in which it was kept dry. The results were as follows:

A.—Series with Dry Filter Paper.

Time of Exposure.	Result. Growth in Broth after:		
	24 hrs.	48 hrs.	72 hrs.
Three similar experiments, 5 min. each	+	+	+
Three similar experiments, 10 min. each	+	+	+
Two similar experiments, 30 min. each	+	+	+
One experiment, 70 min.	—	—	—
One experiment, 2 hours	—	—	—

B.—Series with Moistened Filter Paper.

Time of Exposure.	Result. Growth in Broth after:		
	24 hrs.	48 hrs.	72 hrs.
Two similar experiments, 5 min. each	—	—	—
One experiment, 15 min.	—	—	—
One experiment, 30 min.	—	—	—
One experiment, 60 min.	—	—	—
Control with filter paper alone, in broth	++	++	+++

This series is especially interesting. The potency of the gas is manifest, and in conjunction with the experiments on intestine this series demonstrates the efficiency of the gas acting at a distance and its penetrating effect.

No microscopical change was observed in anthrax spores when treated with solutions of hypochlorous acid of different strengths.

ANIMAL EXPERIMENTS.

In the first series hypochlorous acid alone, in different strengths, was injected into rabbits in order to test its toxic or other effects.

Hypochlorous Acid Alone.

Expt.	Where Injected.	Strength.	Amount.	Result.	Remarks.
1	Subcutaneous	0.37%	5 c.cm.	Lived	No pain, animal not disturbed.
2	Subcutaneous	1.7%	"	Lived	Slight pain, then at ease.
3	Intramuscular	0.37%	"	Lived	When killed muscle was pale from necrosis around injection.
4	Intramuscular	1.7%	"	Lived	
5	Intraperitoneal	0.37%	"	Lived	
6	Intraperitoneal	1.7%	"	Died in 24 hrs.	Pain for a few seconds, lethargic. Haemorrhages in stomach post mortem.
7	Intravenous	0.37%	"	Lived	No pain animal not disturbed.
8	Intravenous	1.7%	"	Died	Death took place suddenly after 2.5 c.cm. had been injected. No thrombosis.
9	Intramuscular	1.2%	"	Lived	Necrosis of muscle, as in (3).
10	Intraperitoneal	1.2%	"	Lived	
11	Intravenous	0.48%	"	Lived	No disturbance whatever.

It was noted in the above experiments that little or no pain resulted from the injections. In the case of the fatal result in (6) it was doubtful whether the injection was responsible, and a similar experiment with a 1.2 per cent. solution caused no disturbance. The most interesting result was seen in (7), where an intravenous injection of a 0.37 per cent. solution caused no disturbance whatever; this is a result which needs further study, and we intend to pursue the point later. The experiment was repeated with 0.48 per cent. solution, and the animal was in no way disturbed. The stronger solution (1.7 per cent.) was fatal to the animal almost immediately; it became suddenly comatose, and after a few sighing respirations it ceased to breathe, the heart beat irregularly for some seconds, and there was no clotting in the heart or vessels. The animals which survived were killed later, and at the site

of inoculation there was oedema of the tissues, and, in the case of the intramuscular injections, distinct necrosis of the muscle along the path of injection occurred, with considerable oedema of the fibres.

The next series of experiments were done with anthrax cultures containing spores. An agar culture was emulsified with 5 c.cm. of normal saline, and equal amounts of Eusol of different strengths were added; 2.5 to 3 c.cm. of this mixture were injected subcutaneously, either at once or after periods of one to five minutes. Emulsions were also made with the Eusol alone, 5 c.cm. being used to wash off one agar culture, and 2 to 3 c.cm. of this injected subcutaneously. Controls were done with equal amounts of anthrax emulsion alone in saline, and with emulsions of anthrax in 1 in 20 phenol.

"Eusol" and Anthrax Spores.

Expt.	Animal and Weight.	Material Injected and Amount.	Time of Contact.	Result.
1	R. 11 D.; 2350 g.	2.5 c.cm. anthrax in saline	—	Died in 48 hrs.; anthrax recovered.
2	R. 12 D.; 1820 g.	2.5 c.cm. anthrax in saline + 2.5 c.cm., 1.2% Eusol	Immediate injection	Died in 3 days; no anthrax found, but Gram-negative coccus.
3	R. 13 D.; 2050 g.	2.5 c.cm. anthrax in saline + 2.5 c.cm. phenol, 1 in 20	Immediate injection	Died in 48 hrs.; anthrax recovered.
4	R. 14 D.; 2050 g.	2.5 c.cm. anthrax in 1.2% Eusol	Immediate Injection	Died in 4 days; anthrax recovered.
5	R. 15 D.; 1960 g.	3 c.cm. anthrax in phenol, 1 in 20	15 min.	Died in 48 hrs.; anthrax recovered.
6	R. 16 D.; 1670 g.	3 c.cm. anthrax in 1.85% Eusol	5 min.	Died in 3 days; anthrax recovered.
7	R. 5 C.; 2250 g.	3 c.cm. anthrax in phenol, 1 in 20	15 min.	Died in 3 days; anthrax recovered.
8	R. 6 C.; 2040 g.	3 c.cm. anthrax in 1% Eusol	5 min.	Lived.
9	R. 7 C.; 2300 g.	3 c.cm. anthrax in 0.5% Eusol	5 min.	Died in 3 days; anthrax recovered.
10	R. 17 D.; 2090 g.	Emulsion of anthrax in saline and filtered through glass wool; 2 c.cm. of this mixed with 2 c.cm. 1% Eusol, 1 c.cm. of mixture injected (strength of Eusol = 0.5%)	1 min.	Lived.
11	R. 18 D.; 2000 g.	Do. do.	2 min.	Lived.

Cultures were made from the anthrax culture before emulsification, and all were positive. After treatment with phenol, cultures were made in Experiments 5 and 7, and these were positive. Cultures were made from the emulsions containing Eusol in Experiments 6, 8, 9, 10, and 11 were negative.

It was found impossible to avoid the formation of lumps of culture in the emulsions, especially those made with Eusol direct; consequently in the last two experiments the lumps were removed by filtration through glass wool, leaving a uniform opalescent emulsion. The difference between the cultural and the animal results is to be explained by the fact that, in making the culture from the injection fluid, only a loopful of the fluid was taken, while both fluid and lumps were injected into the animals.

It will be noticed that even where the unfiltered emulsion was injected death was delayed as compared with the phenol experiments; death was due to the survival of organisms in the lumps. The experiments with filtered emulsion bear this out. Where phenol was used the animals died in every case, even although the phenol was allowed to remain in contact with the anthrax for fifteen minutes before injection.

These results are quite in keeping with the previous results of the action of Eusol on anthrax cultures, and they show that the organisms are killed, and have not merely their power of growth inhibited. Further, the spores are killed as well as the bacteria.

A microscopical examination of a drop of fresh blood mixed with an equal amount of 0.5 per cent. Eusol showed

no obvious change in either red corpuscles, leucocytes, or platelets; at the end of a quarter of an hour a finely granular precipitate appeared in the film, which became slightly opaque; the colour of the haemoglobin was not discharged.

CLINICAL OBSERVATIONS.

Through the kindness of our surgical colleagues we have had the opportunity of observing the results of treatment with hypochlorous acid in a number of cases.

The following statement gives the conclusions which have been justified by the application of the method in practice. As will be seen, this part of the investigation is still in an early stage, and further clinical observations will show how far the promise of the laboratory results can be realized in practice. It is only necessary here to deal with the cases in groups, reference to individual cases will be made where some special point is illustrated.

Considerably over 100 cases of all kinds have been treated with the antiseptic in one form or another.

The first group of cases is that from the surgical out-patient department of the Royal Infirmary, Edinburgh. It comprises the usual list of injuries, wounds chiefly of the head and hands, lacerated, contused, or incised, many septic.

Eusol (0.5 per cent. hypochlorous acid) was employed in this series as a lotion, a soak covered with waterproof, or a dry dressing—that is, gauze wrung out of the solution and then applied with the usual covering of wool and bandage. For comparison, similar injuries were treated with tincture of iodine or with boric soaks.

Over 50 cases have been treated, and it was noted that the majority of septic cases were clean in one to three days and healed in seven to fourteen days. In control septic cases treated with boric soaks four to six days were usually required to clean the wound.

In clean injuries little difference was to be observed between the Eusol-treated cases and the iodine-treated cases, but much less smarting was produced by the Eusol; this was especially noticed in the case of children.

In several cases where the wound appeared to be clean sepsis appeared where only Eusol dry dressings had been applied; this sepsis was removed by one application of a Eusol soak, and its appearance is to be ascribed to a too weak application having been put on in the first instance. In some cases treated with tincture of iodine sepsis also appeared, and this was easily removed by a Eusol soak, one application for twenty-four hours usually being sufficient.

The second series consisted of fourteen cases, mostly in children, occurring in the out-patient department of the Deaconess Hospital, Edinburgh. It comprised cut heads, whitlows, septic ulcers, and boils.

Both Eusol and Eupad were used in this series. The Eusol was used as in the first series. The Eupad was employed dusted on moistened gauze, and applied as a soak for five to thirty minutes; if pain occurred the soak was removed; in two cases—a cut head and a whitlow—the soak remained on for twenty-four hours with no bad results. After the Eupad dressing was removed, a Eusol soak or dry dressing was applied as the circumstances indicated. In these cases with Eupad the gas was the chief agent.

No pain was caused by the Eupad on the cut heads, and in twenty-four hours, when the dressing was removed, the cuts were clean and dry, and healing occurred uneventfully in three to six days.

The whitlows also rapidly cleaned under the Eupad dressings followed by Eusol soaks, and no pain was complained of. A large boil on the leg was opened, and a drain of gauze powdered with Eupad was inserted; on the second day the wound was dry, and no pus could be expressed; the drain was repeated for another day, and afterwards only dry sterile gauze put on; it had completely healed by the ninth day.

In one case of septic sores on the arm of a child a Eupad dressing caused pain and slight vesication. This was one of the early cases where the amount of Eupad used was in excess of what was required. Also the wound was on the flexor aspect of the arm where the skin is much more easily irritated than that of the scalp.

A series similar to the last, except that the patients were adults, was obtained from the Victoria Hospital, Edinburgh, at present used as an auxiliary Red Cross hospital.

The cases were mostly superficial wounds due to shrapnel. Eupad was chiefly used and it was applied either dusted on directly as a powder, or dusted on gauze and moistened; some cases had it applied as a fomentation. The Eusol was used at first chiefly as a lotion to wash the wounds, and later fomentations of it were applied. The results were very satisfactory in whatever way used; septic wounds rapidly cleaned and only in a few cases was pain complained of. It was noticed that where pain occurred it was the skin around the wound that showed signs of slight irritation and not the wound itself; by smearing vaseline on the skin around this effect was obviated. In one case only was actual vesication produced and only of very slight degree; this was a case in which the moist gauze containing Eupad had been too long and had been folded double at one end—this caused a too great concentration of the gas from the powder and consequent irritation. One case of a discharging sinus due to a bullet wound was drained by a wick of wool dusted with Eupad; within two days the discharge became serous.

In order to see if the powder could be applied in a practical form as a first field dressing, another series of cases was done at the Royal Infirmary surgical out-patient department. Sterile gauze pads, of the same size and folded in the same way as the regular first field dressing supplied to soldiers, were made, and in the centre was placed a definite amount of Eupad; at first 1 gram was inserted, but as that was found to be completely exhausted in use, 2 grams were used later. These pads were applied to injuries such as cut heads and hands when the cases were admitted to the out-patient department; if the wound were bleeding, the blood was allowed to damp the gauze; if bleeding had ceased, the pad was moistened with a little water. The pads were allowed to remain on the wound for twenty-four hours, and then further treatment was employed as indicated. Seven cases were treated with pads, and the wounds were clean on the patients' return; no pain or discomfort was complained of.

Where only 1 gram of powder was placed in the pad, no trace of hypochlorous acid could be smelt after twenty-four hours' application, but with 2 grams a slight odour was still present in the damp powder.

Recently in the same department a number of cases of chronic ulcers of the leg have been treated with Eupad, either dusted on directly or applied on damp gauze. The results have been very striking: several ulcers which had been treated with the usual methods for weeks with no apparent improvement cleaned up in a few days under Eupad.

The antiseptic has also been applied in large wounds. In the Dalmeny House Hospital (Red Cross) a number of severe shrapnel wounds have been treated with Eusol; it will be sufficient for the present purpose to refer to two of the worst cases.

CASE I.

The first was that of a soldier who had a compound comminuted fracture of the left femur. He was admitted to Dalmeny House Hospital about one month after the wound was received. There was much pain and copious foul-smelling discharge from two sinuses on the front and back of the thigh, and there was pus around the fragments of bone seen by the *x* rays; the temperature was raised. The wound was treated for some weeks with hydrogen peroxide syringed through; then weak tincture of iodine was similarly employed. Progress was very slow. Eusol (0.5 HClO) was then used in the same manner, and within three days the odour had disappeared and the discharge and pain were much less; within ten days the temperature had fallen to normal and the patient felt much easier. The discharge gradually became less and serous in character and the fetor did not return. The Eusol treatment was kept up, and improvement was steady and marked. *X*-ray photographs showed callus forming around the splintered ends, and now the bone has united and the sinuses are practically closed. From the pus a Gram-negative bacillus of the *coli* group was isolated. In this case there seems no reason to doubt that definite improvement followed the application of Eusol.

CASE II.

The second case was that of a soldier who had a severe shrapnel wound of the right arm, received on May 5th at Hill 60. He had been treated with boric soaks until admitted to Dalmeny House Hospital on May 15th. On admission there was extensive laceration of the extensor muscles and the radius was shattered; a gaping ragged

wound was present, bathed in foul-smelling pus; there was great pain and the temperature was swinging. A soak of Eusol (0.5 per cent. HClO) diluted 1 in 4 with sterile water was applied, but had to be removed as so much pain was complained of. A dressing of hyperisotonic saline was then applied; this was also painful. Eusol was then made up in normal saline in 1 in 10 strength, and this was borne without undue pain as an arm-bath for one hour. This was repeated daily. The odour disappeared after one or two applications, the wound rapidly cleaned up, and pain disappeared. The temperature dropped in a few days to normal. By May 31st there was marked improvement and the wound was clean and granulating in spite of the fact that there were fragments of bone and shrapnel still to come away. On June 7th healing was well advanced, and only a little serous discharge was present. Skin grafting was performed on the 19th and took, and the wound was practically completely healed on June 30th.

In the ear and throat department of the Royal Infirmary cases of cerebellar abscess have been washed out with Eusol with good results; immediate removal of the marked fetor present occurred. It has also been employed in mastoid operations with similar encouraging results.

In the maternity hospital Eusol has been used, full strength, as a douche, and caused rapid diminution of discharge.

Both Eusol and Eupad have been used in several of the wards of the infirmary and by some of our surgical colleagues in their private practice; cases such as the following have been treated: Periappendicular abscess, perineal abscess, cystitis, gangrene of feet, pyorrhoea alveolaris, follicular tonsillitis.

The general conclusion from the clinical observations is that hypochlorous acid, both in solution and as a gas, has a high antiseptic value in surgical practice.

Since there is no danger of absorption of the antiseptic or its decomposition products the rule may be safely followed of applying the antiseptic in the strongest form consistent with the comfort of the patient.

Any bad effects that might arise are purely local in incidence, and therefore easily controlled.

Eusol (0.5 per cent. HClO) has so far given no indication of deleterious action even on devitalized tissues, and may be used, therefore, with impunity in full strength. Eupad, which acts in virtue of the gas given off, is much more powerful in its antiseptic action and causes more irritation. The irritation, however, chiefly affects the surrounding skin and can easily be obviated. Pain is a useful warning that the application should be diluted.

The strongest effect observed in a wound was a superficial bleaching of the tissue and slight blistering of the surrounding skin; this was only produced by a thick layer of moistened powder. We have never seen any sign of necrosis in the form of slough formation. When the powder amounts to one or two grams enclosed in a gauze pad no harmful effect is to be anticipated.

Further investigation is required to define the nature of the reaction which hypochlorous acid causes in the tissues. Although it kills organisms so rapidly, no disintegration occurs; and there is no apparent breaking down of tissue cells.

It causes congestion and oedema, and there is a flow of lymph from the surface of the wound. Two factors are at work here: a direct action by the acid on the blood vessels, and the hyperisotonic effect of the salts in solution; when the solution is diluted the hyperisotonic effect is correspondingly reduced, and the antiseptic action alone remains. It is unquestionably of the greatest value that this solution combines the hyperisotonic effect with intense antiseptic power, small risk of damage to the tissues, and entire absence of toxic absorption.

It is a matter for further investigation to inquire how far benefit may be derived from the addition of sodium chloride to the solution to increase its hyperisotonicity.

When the antiseptic is applied to a wound the discharge in the first place loses any fetor which may have been present, and from being purulent rapidly becomes serous.

The antiseptic is easily exhausted, and therefore requires frequent renewal. It should be clearly understood that the function of this antiseptic is the elimination of sepsis; once sepsis is removed from the wound it may be discontinued and replaced by any bland dressing. It is in the treatment of septic wounds that the special power of this antiseptic is made manifest.

It is to be noted that hypochlorous acid tarnishes metals, and therefore instruments should be kept in a separate cupboard, and not left in the solution longer than necessary. It bleaches and destroys cloth fabrics if left in contact with them for a prolonged period.

An important point in connexion with this antiseptic is that the ingredients are easily obtained, and at a very small outlay. The cost of making one gallon of Eusol is approximately one penny.

METHODS OF USE.

It is convenient to group these under an independent heading. While we indicate those methods we have observed in use, there are no doubt others which further experience will suggest.

(a) *Eusol*.—Standard strength, approximately 0.5 per cent. hypochlorous acid.

1. As a lotion; diluted, if necessary, with water or normal saline.
2. As a fomentation; covered with waterproof.
3. On gauze wrung out of the solution and applied without a waterproof covering.
4. As a bath; full strength, or diluted as indicated.

(b) *Eupad*.—Where it is desired to apply a more concentrated antiseptic Eupad may be employed as follows:

1. Eupad enclosed between layers of gauze or lint charged with water sufficient to moisten the powder; this is applied to the wound and covered with wool and a bandage.
2. Applied as above, but covered with waterproof. This should be applied only for a short period—ten to twenty minutes as a rule. Occasionally this strong application causes pain, and, should this occur, a weaker application is indicated.
3. On strands of gauze or wool impregnated with the powder and used for drainage.
4. As a dusting powder—for example, on open septic sores.

The general principle of the antiseptic application is that it should secure the maximum antiseptic effect with the minimum of local irritation.

Where it is found desirable to increase the antiseptic effect of the solution, a little of the powder may be added to it just before it is applied, or a small amount of powder may be dusted on to the wet gauze. In these ways the action of the solution may be reinforced.

In conclusion we have to express our indebtedness to members of the surgical staffs of the hospitals to which we have referred for their kind co-operation and help in this investigation.

CONCLUSIONS.

1. Comparative tests confirm the conclusion already arrived at by various investigators that hypochlorous acid is the most powerful antiseptic known.
2. Practical methods of using this antiseptic have been devised.
3. It can be used either as a gas or as a solution. The advantage of using the gas is that it will penetrate and will act at a distance.
4. Both the gas and the solution, while extremely potent against organisms and their spores, cause little or no harm to the tissues.
5. The effect of this antiseptic is purely local; the decomposition products are devoid of toxicity, and there is therefore no danger to be apprehended from absorption.
6. A flow of lymph is induced from the wound as part of the reaction of the tissues.
7. Fetor is rapidly eliminated.
8. If pain and irritation occur they can be easily controlled by reducing the concentration of the antiseptic.
9. The practical advantages of this antiseptic for *field use* are:
 - (a) It can be used as a dry powder and therefore obviates the difficulty of procuring water.
 - (b) It can be introduced into the gauze pad of the first field dressing.
 - (c) Where water is available the same powder can be made up as a lotion for general use.
10. The constituents of the powder are inexpensive and easily procured; and the preparation of the antiseptic is extremely simple.

11. For convenience the powder has been called "Eupad" and the solution of hypochlorous acid "Eusol."

This investigation was undertaken at the request of the Medical Research Committee.

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HINTS ON WAR SURGERY.

BY

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THIS unpretentious paper, made up of hints derived from practical experience, has been written at the suggestion of some of my young friends who have been called to serve almost immediately after receiving their qualification to practise, and of others who have been engaged in general practice for years but have felt it their duty to offer their services to the State in this time of great national need.

Practically all the injuries requiring attention are gunshot wounds due to rifle bullets, pieces of shell or shrapnel bullets—the first being pointed, the second irregular in shape and size, and the third round.

The wounds from rifle bullets are frequently small and aseptic, but if the missile has turned on its axis, has been diverted in its course, or has first struck the ground, it may make a very large wound, and in the last case may be septic.

The velocity of a rifle bullet in the first thousand yards being very great, a hard bone if it be struck will be shattered, and the separate fragments of bone may have so much force transmitted to them that each becomes a mischievous projectile.

Tincture of iodine seems to be the best antiseptic for use in the fighting line. Every soldier should therefore have a small quantity with him, so that he can apply a little to the wounds and to the skin for half an inch around them before applying the protective gauze pads.

The first dressing should not, as a rule, be disturbed until a hospital is reached unless there be haemorrhage, in which case it will be advisable to change it at the first dressing station in order to arrest the bleeding; if the haemorrhage is only slight, compression over the first dressing may suffice until a hospital is reached.

If, on reaching a hospital, the first dressing is dry and sticking to the wound, and there is neither pain nor bleeding, the dressing need not be disturbed.

Unless absolutely necessary, as for haemorrhage or other emergency, it is undesirable to perform set operations on the field or in transit, whether on a hospital ship or train.

Although bullet wounds are frequently aseptic and do not require a change of dressing, yet, if the wound be extensive or septic, they should be treated like shell wounds.

Shell and shrapnel wounds are, as a rule, septic, and should be freely irrigated and drained, the irrigation being subsequently repeated twice or thrice daily if possible. The best fluid for irrigation is normal saline solution, but sea water drawn from the hot-water service taps on board the hospital ships or taken up from the sea two miles from shore, or plain boiled water, or weak iodine water, or a light pink solution of potassium permanganate may be equally well used. After irrigation and free drainage the wound may be filled with a 10 per cent. saline solution or with hydrogen peroxide solution 5 to 10 per cent., but it is senseless waste to use an expensive antiseptic solution to irrigate wounds.

If the drainage is not free the wound must be enlarged or a counter opening made. The dressings must be applied in such a way as not to occlude the drainage tubes.

The removal of bullets and pieces of shell is not necessary unless the foreign bodies are causing pain, keeping up suppuration, or lying in positions dangerous to vessels, nerves, or joints.

The greater number of nerve injuries recover spontaneously, therefore early operations on nerves are to be deprecated.

In primary or recurrent haemorrhage on the field pressure should, as a rule, be adopted, and only in exceptional cases is it necessary or desirable to ligature vessels, but if the pressure has not effected its purpose the bleeding vessel or vessels must be ligatured at the first dressing station.

In secondary haemorrhage it is not well to wait for repeated bleedings but to ligature the bleeding vessel without delay, as the next haemorrhage may be fatal or may so far reduce the strength of the patient that amputation may be necessary, or possibly further treatment may even be impossible.

If, owing to unavoidable delay or to deficient drainage, gas gangrene threatens or has actually developed, a 10 per cent. solution of hydrogen peroxide should be injected deeply into the tissues at various points beyond the infected area and free incision made into the gangrenous tissues and thorough irrigation and drainage carried out.

In gas gangrene of the extremities subsequent to the treatment just mentioned the arm or leg bath can be advantageously employed, but where that is impracticable boric or iodized water poultices can be used and changed every four hours.

The application of sutures to lacerated or infected wounds should be avoided.

In abdominal injuries a morphine injection should be given or a tabloid of morphine administered by the mouth immediately the patient is discovered. It is desirable to avoid giving food, and, as far as possible, even fluid, by the mouth. Thirst may be quenched by rectal injections of normal saline fluid. These cases nearly always die if transported far in an early stage, therefore let them remain as long as possible near the front.

If peritonitis supervenes, the patient should be propped up in the Fowler position, and drained above the pubes. The operation can be carried out under local anaesthesia in a few minutes. The abdomen should not be washed, and any long operation should be avoided until the base hospital is reached, when, should anything be called for, it can be done under the most favourable conditions.

Serious head injuries bear transport badly, and must be operated on as soon as possible for the removal of blood clot and depressed bone causing pressure on the brain.

Fracture of the long bones and injuries to joints should be immobilized by splints or some temporary apparatus, obtained on the spot before removal from the field.

Conservatism is the rule of treatment for fractures, and amputation should be avoided or rarely adopted as the only possible alternative. Immediate amputation is only called for in case of complete smashing or almost total tearing off of a limb.

Later, amputation may be required for traumatic gangrene or for rapid extension of gas gangrene, and, rarely, for extensive diffused aneurysm, or for serious wound complications attended with osteomyelitis and extensive suppuration.

In all shell wounds or septic bullet wounds a dose of antitetanic serum should be administered as a prophylactic as early as possible after the injury.

In erysipelas or any streptococcal infection the use of antistreptococcal serum should not be omitted.

THE late Surgeon-General Arthur James Payne left unsettled property to the value of £49,983.

THE governors of the Tower Hamlets Dispensary, an institution founded in 1792, and carried on until recently in Stepney, resolved a few months ago to close it. This resolve was due partly to the difficulty of collecting funds, and partly to the diminution in the number of patients attributed to the Insurance Act, and to the establishment of tuberculosis dispensaries, and of medical treatment centres for school children. At a meeting on July 12th the governors received a deputation from the Stepney Board of Guardians, who desired that the dispensary should be continued, and promised an increased subscription from the board. Dr. Corner said that medical practitioners in the district regretted the closing of the dispensary, but the chairman held that that matter could not be reopened, the only question to be determined being the best method of disposing of the sum of £450, the net cash balance in the hands of the governors, who, however, also own the building, valued at £650. The meeting appears to have separated without coming to any definite decision.